Unit 37: Refrigeration Technology in Building Services Engineering

NQF Level 3: **BTEC National**

Guided learning hours: 60

Unit abstract

Modern refrigeration has many applications in our lives today, such as the safe preservation of medicine, blood and, most importantly, food. However, within construction and the built environment, refrigeration technology is also widely used in air conditioning systems for the maintenance of human comfort.

People expect to live and work in comfort in the 21st century. This and climate change have created a demand for skilled design engineers and technicians in both heating and cooling.

Under pressure from the increasingly tight requirements of the Environment Agency, it is essential that building services design engineers and technicians keep up to date with the latest developments in refrigeration and air conditioning technology. It is increasingly important that they are able to apply the fundamental underpinning knowledge of refrigeration processes to all design proposals.

This unit introduces learners to the study of thermodynamic properties of refrigerants and to the basic calculations used to determine the capacities of each of the components used in the single stage refrigeration cycle.

The focus of this unit is on linking principles with practical refrigeration applications, and learners should have a basic understanding of the associated science, technology and analytical methods, or have started studying these, before undertaking it.

Learning outcomes

On completion of this unit a learner should:

1. Understand the principles, design parameters, thermodynamic properties and laws associated with basic refrigeration processes
2. Be able to identify different types of refrigerants and demonstrate an understanding of the correct use and configuration of refrigeration system components
3. Be able to assemble basic project design proposals and select appropriate refrigeration technology
4. Understand the technical and operational requirements for correct, safe, energy efficient system installations on site
5. Know how the current legislation, British Standards, regulations and codes of practice applicable to refrigeration technology are correctly applied to design and installation procedures.

Unit content

1 **Understand the principles, design parameters, thermodynamic properties and laws associated with basic refrigeration processes**

Basic physics: general temperature scales used (eg Celsius, Kelvin/absolute temperature scale); application of gas laws (eg Dalton's Law, Boyle's Law, Charles's Law, general gas law)

Heat and temperatures: heat transfer; removal of heat refrigeration processes; data table for enthalpy; sensible and latent heat; boiling point of liquids; room temperatures; discharge and comfort temperatures; coil temperatures; storage temperatures; suction and condensing temperatures; transient heat flow; two-phase heat transfer; dew point and wet bulb temperatures

Refrigeration cycles: basic vapour compression cycle; evaporation and condensation of a liquid; coefficient of performance; ideal reversed Carnot cycle; modified reversed Carnot cycle; use of pressure-enthalpy diagrams; volumetric efficiency; multi-stage cycles; absorption cycle; air cycle; working fluid condition throughout the refrigeration and air conditioning cycles

2 Be able to identify different types of refrigerants and demonstrate an understanding of the correct use and configuration of refrigeration system components

Refrigerants: characteristics, applications and operational features; background and changes to legislation on use of certain types of refrigerants; environmental impact and issues of refrigerants; ozone layer and depletion potential; global warming potential; current refrigerants in use; ideal properties of a refrigerant, eg ammonia and hydrocarbons; refrigerant blends; lubricants; transport handling and distribution; criteria for selection

Compressors: characteristics, applications and operational features; capacity ratings as applied to the vapour compression cycle; history of positive displacement (piston type); multi-cylinder type compressors, construction and use, valve types and applications; sliding and rotary vane compressors; screw compressors; scroll compressors; dynamic (centrifugal) compressors; criteria for selection

Condensers and water towers: characteristics, applications and operational features; condenser capacities and manufacturers' equipment cooling capacities; rating and sizing; use of data tables; air cooled condensers; construction and materials used in manufacture; liquefied refrigerant and air flows; natural and forced convection methods; water cooled condensers; typical configurations and sizes; efficiencies and adaptability; shell and tube condensers; cooling towers; evaporation processes and water quantities; issues with spray vapour; evaporative condensers; atmospheric condensers; winter operation factors that are commonly applied to condensers; heat pump or heat reclaim systems; criteria for selection

Receivers: characteristics, applications and operational features; holding capacities; materials used to manufacture; pressure vessel and requirement for safety pressure relief devices; criteria for selection

Dry coolers: characteristics, applications and operational features; limitations of use; criteria for selection

Evaporators: characteristics, applications and operational features; flow pattern and function; flooded evaporators; plate evaporators; methods and requirements for defrosting; shell and tube evaporators; shell and coil evaporators; air cooling evaporators, liquid cooling evaporators, performance and efficiencies; materials used in manufacture; configuration of typical models; floor or ceiling mounted; dry expansion methods; advantages and criteria for selection; requirements for condensate pumps and drainage of condensate water

Expansion valves: characteristics, applications and operational features; understanding the need and the importance and function of an expansion valve to refrigeration systems; methods of achieving pressure reduction; low-pressure float valves and switches; high pressure float valves; thermostatic level control, use as metering/monitoring devices and typical signals conveyed via other control devices, such as solenoid valves for safe control of systems; valves for dry expansion circuits; detection of superheat method of operation; correct selection and installation to avoid undamped proportional control; electronic expansion valve use in packaged, automatic units/systems and field use; use of thermistors to sense superheat with pulsing or modulation solenoid valve for final control as an integrated control unit; use of thermal electric expansion valve and capillary tube restrictor; criteria for selection

3 **Be able to assemble basic project design proposals and select appropriate refrigeration technology**

Design principles: refrigeration load estimation; load sources; appropriate removal of heat; consideration of all heat sources; consideration of sensible and latent heat gains from relevant sources; conducted heat, convected heat; internal heat sources; heat of respiration; carrying out estimate analysis; use of quantative data; selection of design parameters; effects on human comfort and climate conditions; environmental deign parameters; provision of suitable layout drawings and flow diagrams; control and wiring circuits

Calculations: requirements for the calculation of air conditioning and comfort cooling; winter heating via heat pumps; sensible and latent cooling; adiabatic cooling/saturation cooling and dehumidifying coils; sensible-latent heat ratio; evaporative coolers; running time for refrigeration plant to overcome given cooling loads

Types of systems: characteristics, applications and operational features; understanding the need and the importance and function of the various different types of air conditioning systems that use refrigeration to provide both heating and cooling; all air systems using centralised plant and ductwork with associated cooling coils in air handling equipment; direct expansion systems supplied with refrigerant from a central plant room; chilled water air handling unit taking chilled water from a central chiller; water-cooled, packaged, direct expansion unit using condenser water from an external tower; remote condenser (single split) air-cooled direct expansion unit; air-cooled direct expansion unit local to indoor unit; packaged air cooling units; two and three pipe split units; multisplit VRF units; criteria for selection

4 Understand the technical and operational requirements for correct, safe, energy efficient system installations on site

Materials: use of standard engineering materials for refrigeration plant and equipment, eg usually copper with attention to special requirements for compressors and compressor pistons, piping systems in stainless steel, mild steel, aluminium tube for ammonia

Piping layouts: characteristics, applications and operational features; correct sizing and routing of pipe work systems; pipe–joining methods for steel and copper; flanged and welded steel pipe work for larger commercial systems; mechanical joints for copper tube; flare type joints with annealed tube; brazing of copper tube; using copper tube on rolls to minimise jointing; attention to detail for evaporator and condenser positions above and below the compressor with relevant gravity falls and taps as required for oil return

Pipe supports: frequency of supports required limiting stress and deflection; allowances for expansion and contraction; limit damage and use access as footholds; blocking access to isolation valves; various types available to market place for different sizes of installation

Instruments: locations of permanently fixed instruments (pressure gauges, thermometers and electronic thermocouples) for use in initial and final commissioning and on-going system maintenance; use of manometers across air filters where applicable

Vibration: use of anti-vibration mounts for machinery; use of braided flexible connectors for pipe work connections

Site pressure safety tests: necessity for pressure tests on completes installations; checks for factory tested components and pressure vessels; use and supply of nitrogen and relevant pressures to test installation, eg gauges used to test pressure, vented during pressure tests, checking and operation of system valves during pressure testing, maintenance time for the pressure test

Evacuation: principles of evacuation; removal of air and moisture from pipe work system; operating temperatures of refrigerants and absolute pressures; use of vacuum pump and expansion valves for connection; final working pressures purging system of air; automatic gas purgers

Charging system: operational procedures for charging system with refrigerant as a liquid; allowance of refrigerant for systems with receivers and changes in seasonal loads; checking charging weights for small systems; replenishing of oil in system; checking sight glasses

Insulation: application of insulating material to low pressure pipe work and materials currently available; methods of application to pipe work and/or equipment where necessary; elimination of air and moisture; creating a vapour barrier; sealing of joints; use of specialist trades for application

Commissioning: completion stage of contract; checking design specification requirements; setting to work procedures and logical sequence of events; calibration and final checks; commissioning records

5 Know how the current legislation, British Standards, regulations and codes of practice applicable to refrigeration technology are correctly applied to design and installation procedures

General safety: safe installation and use of electrical plant and equipment (preventing electrical shock, earthing requirements, fuses and safety devices); storage and handling of gas cylinders; use and correct application of eg dangerous and flammable chemicals, oil, solvents, spilt mercury, disposal of waste chemicals; manual handling and lifting of plant and equipment; hazard warning and identification; first aid; correct operating, installation and testing procedures; personal protective equipment

Legislation: importance of health and safety standards; knowledge of current and applicable legislation under the Health and Safety at Work Act (1974); implications of breaches of applicable laws; adherence to national and international protocols and environmental legislation on use, provision and handling of refrigerants; requirements for training, qualified and competent personnel for installation, commissioning and testing procedures

British Standards and regulations: relevance and application of information contained within eg BS 4434:1989, BS 5720:1979 — no longer current but now cited in Building Regulations — DD 9999:2005, BS EN 378-2:2000, BS EN 378-1:2000, BS 5422:1990, BS 6880-1:1988, BS 6880-2:1988, Building Regulations 2000: Approved Documents L2, or all currently revised standards and regulations as applicable

Codes of practice and other references: relevance and application of information contained within the following documents eg Institute of Refrigeration Safety Codes for Refrigerating Systems utilising groups of HCFC/HFC and hydrocarbons, (A1, A2, A3) types refrigerants; minimisation of refrigerant emissions; use of all relevant CIBSE Guides and Commissioning codes; Code of Practice for Compression Refrigerating Systems using Ammonia 1; use of current HVCA guides and ASHRAE Handbooks; use of BRE documents for energy and efficient designs

Grading grid

In order to pass this unit, the evidence that the learner presents for assessment needs to demonstrate that they can meet all of the learning outcomes for the unit. The criteria for a pass grade describes the level of achievement required to pass this unit.

Grading criteria		
To achieve a pass grade the evidence must show that the learner is able to:	**To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:**	**To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:**
P1 identify the basic principles of thermodynamics as relevant to the general uses of refrigeration	M1 analyse how the refrigeration cycle works, explain and illustrate the thermodynamic changes within the working during the operation of the cycle and its variants	D1 investigate possibilities for new, more recent methods of refrigeration technology used in air conditioning and compare and contrast these to older methods with regard to performance, cost, energy efficiency and overall benefits to the environment
P2 identify the requirements that would make refrigerants an ideal working fluid for the vapour compression cycle and how a variety of modern refrigerants achieve the criteria	M2 produce comprehensive designs for refrigeration and air conditioning installations, plant arrangements, ancillary equipment and control arrangements	D2 appraise all the options available for designers and installers of refrigeration systems and analyse what ultimately determines design solutions to be chosen and consequently the impact on our world today.
P3 establish the features and characteristics of the principal components of refrigeration systems and their configuration for the purpose of providing simple air conditioning solutions	M3 produce clear and accurate answers to calculations to establish the duties, ratings and flow rates for a variety of different refrigeration components and select these using manufacturers' information	

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Grading criteria		
To achieve a pass grade the evidence must show that the learner is able to:	**To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:**	**To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:**
P4 determine sensible and latent heat gains for at least two different building locations requiring air conditioning	M4 analyse installation drawings, design calculations and manufacturers' data to produce clear proposals for the testing, commissioning, planned maintenance and hand-over documentation for refrigeration plant on both integrated and a stand-alone air conditioning systems	
P5 produce a basic, functional and workable designs proposal for a refrigeration-based air conditioning systems for a simple buildings; select and produce a schedule of the required refrigeration plant and equipment	M5 discuss the impact of current and planned national and international protocols and legislation relating to the design, installation, commissioning and use of air conditioning and refrigeration systems.	
P6 specify the material, equipment, instruments and installation requirements necessary to install, test and commission typical refrigeration systems		
P7 outline the most important requirements of current regulations, legislation and codes of practice related to the design, installation, and use of refrigeration systems and all associated substances.		

Essential guidance for tutors

Delivery

Tutors delivering this unit have opportunities to use a wide range of techniques. Lectures, discussions, seminar presentations, site visits, supervised practicals, research using the internet and/or library resources and the use of personal and/or industrial experience are all suitable. Delivery should stimulate, motivate, educate and enthuse learners. Visiting expert speakers could add to the relevance of the subject.

It is important to ensure that learners studying this unit are aware of the planned and progressive structure that exists across the learning outcomes. Before the next step in the learning process can be taken, learners should achieve the knowledge and understanding in the previous learning outcome. There may be cases where learners have gained adequate knowledge and experience before attempting a new learning outcome but this should be proven through an assessment process.

Learners should clearly appreciate that each aspect and topic forms a stage in the overall process of designing and specifying refrigeration plant and equipment and associated installations.

The focus of the unit is on refrigeration within the context of air conditioning and does not deal explicitly with the application of refrigeration technology in relation to cold stores or food and product storage. However, the underlying principles of the thermodynamic and refrigeration processes are much the same and could be applied to this area of design by suitably qualified learners.

This unit should not be seen by learners as an academic exercise. It should be based on real-life applications and reflect industry best practice. The method of delivery should, as far as possible, be activity-based and use learning activities that include the use of laboratory work, case studies, site visits, product investigations, design exercises etc. The delivery process should provide a balance between calculations, knowledge, understanding, creativity and application. These should always pay appropriate attention to health, safety and welfare requirements.

Learners should be encouraged to refer to documents such as CIBSE guides, ASHRAE handbooks, codes of practice, British Standards and building regulations, to gain a wide and confirmed range of advice on best practices for design and installation requirements. The use of manufacturers' current product information is also encouraged to help learners apply the principles and procedures that would be used in industry.

Emphasis on the need for learners to understand how to access and use particular charts and diagrams to aid manual calculations is very important. Industry standard software can be used to perform certain design functions in the process of assembling a project. However, it is important that learners can challenge any results gained from the software by carrying out either 'rule of thumb' or longhand manual calculations.

The focus of this unit is on linking principles with practical applications and this in turn means that learners should have achieved a basic understanding of any relevant science and mathematics before starting this unit. This should include the underlying principles of thermal comfort, heat transfer, processes that harm the natural environment, psychrometric properties of moist air, flow of fluids, and control principles and strategies for building engineering services.

Group activities are permissible, but tutors will need to ensure that individual learners are provided with equal experiential and assessment opportunities.

Health, safety and welfare issues are paramount and should be strictly reinforced through close supervision of all workshops and activity areas, and risk assessments must be undertaken prior to practical activities. Centres are advised to read the *Delivery approach* section on page 24, and *Annexe G: Provision and Use of Work Equipment Regulations 1998 (PUWER)*.

Assessment

Evidence for this unit may be gathered from a variety of sources, including well-planned investigative assignments, case studies or reports of practical assignments.

There are many suitable forms of assessment that could be employed, and tutors are encouraged to consider and adopt these where appropriate. Some examples of possible assessment approaches are suggested below. However, these are not intended to be prescriptive or restrictive, and are provided as an illustration of the alternative forms of assessment evidence that would be acceptable. General guidance on the design of suitable assignments is available on page 19 of this specification.

Some criteria can be assessed directly by the tutor during practical activities. If this approach is used then suitable evidence would be observation records or witness statements. Guidance on their use is provided on the Edexcel website.

The unit allows for flexibility in the various types of assessment methods that can be used throughout the assessment criteria. Certain criteria however, require well-planned laboratory work, assignments that involve the inclusion of calculations, diagrams and text, or design project work.

The fundamental principles of the refrigeration processes are often best witnessed and demonstrated to see the effects and results. Experiments in a laboratory to demonstrate different processes and use of equipment could be undertaken by the learners with evidence for assessment presented as a combination of a visual record by the assessor and preparation and maintenance of suitable logbooks. Learners could also provide work-based evidence for assessment provided that this evidence is appropriate and authenticated as the learner's own work.

Where projects are used as assessment tools they should be selected to include a variety of activities, functions, features and uses. This will ensure that learners are able to consider options and make decisions.

The buildings selected for projects should be those typically encountered and designed in industry so that they can be related to normal practice in the workplace. They should have a variety of spaces and areas with differing requirements to stimulate learners' thinking . They should be capable of being air conditioned using the option of stand-alone refrigeration systems or plant and equipment that is integrated into larger centralised systems.

Learners should preferably be provided with a range of the architectural drawings needed for them to extract the information required including plans, elevations, sections and details. If centres want to use a building of their own design, it should meet current building design standards and contain the same information as would be expected from modern professionally produced architectural drawings.

Although this unit can be assessed as a stand-alone unit, it is advisable that, wherever learners are concurrently studying other units, the assessment evidence be co-ordinated to avoid duplication. To achieve this, centres are encouraged to consider integrative assignments containing grading criteria from other units. For example, assessments associated with thermal comfort, properties of materials, sustainable development, environmental impact, psychrometric properties of air, flow of fluids, performance of fans or control applications can all be integrated within an assessment instrument designed to meet the grading criteria for this unit.

To achieve a pass grade learners must meet the seven pass criteria listed in the grading grid.

For P1, learners must identify the basic principles of thermodynamics as relevant to the general uses of refrigeration. They are expected to identify the different behaviour of liquid and vapours under different situations and the processes and phases that refrigerants undergo during the removal of heat. Learners will calculate the differences in moisture in given quantities of air and be familiar with the processes of evaporation and condensation of water. They must also identify how different thermodynamic laws relate to the provision of refrigeration technology. Evidence could be in the form of a report, supported by standard charts and graphs and appropriate calculations.

For P2, learners must identify the requirements that would make refrigerants an ideal working fluid for the vapour compression cycle and how a variety of modern refrigerants achieve the criteria. They are expected to identify the currently used refrigerants available for use in air conditioning systems and discuss the advantages and disadvantages. Learners are expected to determine the refrigerants that meet current environmental standards and protocols. They should also discuss the reasons why certain refrigerants are either no longer viable options for use at all or only suitable in certain types of systems. Evidence could be in the form of a presentation, a report or through oral questioning.

For P3, learners must establish the features and characteristics of the principle components of refrigeration systems and their configuration for the purpose of providing simple air conditioning solutions. Learners need to produce diagrams, sketches and descriptions of the components to discuss their location, function and features in systems and how they assist in providing solutions for air conditioning. They must provide evidence of having considered environmental and health, safety and welfare aspects. Suitable evidence could be as for P2.

For P4, learners must determine sensible and latent heat gains for at least two different building locations requiring air conditioning. The buildings specified should have quite different requirements that learners are expected to consider in order to develop a brief. They should be able to use given data on heat loads, and/or assess other incidental heat loads that may be present, in order to manually calculate sensible and latent heat gains. This could be used as an integral part of a design project. Suitable evidence could be as for P1, supported by suitable drawings.

For P5, learners must produce a basic, functional and workable designs proposal for a refrigeration based air conditioning system for a simple building; select and produce a schedule of the required refrigeration plant and equipment. They must assemble a full design proposal for the provision of a suitable air conditioning system incorporating refrigeration technology in any form that they feel is applicable for the chosen building. This will include the creation of layout drawings to indicate the system proposals, plant and equipment schedules, pipe work routes and plant and equipment detail drawings. This could be used as an integral part of a design project. Evidence could take the form of drawings supported by calculations.

For P6, learners must specify the material, equipment, instruments and installation requirements necessary to install, test and commission typical refrigeration systems. They are expected to prepare an outline installation specification for the design proposal created in P5, detailing all the materials and ancillary equipment needed for on-site installation. Learners should provide sketch details or pictures in the specification. They should also provide a briefing document that advises on the basic methods to be used for testing and commissioning the installation. P6 could be used as an integral part of a design project.

For P7, learners must outline the most important requirements of current regulations, legislation and codes of practice related to the design, installation, and use of refrigeration systems and all associated substances. They are expected to identify the main documents that detail the important legislation, regulations and codes of practice relevant to refrigeration. Learners must show their understanding of the implication of these requirements for the designer, installer and end user, in terms of the environment, financial cost and personal health and safety. Evidence could take the form of a referenced report.

To achieve a merit grade learners must meet all of the pass grade criteria **and** the five merit grade criteria.

For M1, learners must analyse how the refrigeration cycle works, explain and illustrate the thermodynamic changes within the working during the operation of the cycle and its variants. This could be through the provision of written descriptions about the actual processes of the gases and liquids. They should use clear diagrams to indicate the various cycles that exist and the components used to create the cycles. Learners will be able to build and expand on knowledge gained for P1.

For M2, learners must produce comprehensive designs for refrigeration and air conditioning installations, plant arrangements, ancillary equipment and control arrangements. The designs should include details of all items of plant and equipment (including controls) and their locations. There should be clear evidence that learners have carefully considered the proposed design including features and constraints of the building, the space requirements for the accommodation of the refrigeration plant and associated equipment, pipe work routes, and the client's requirements. Drawings and reports should be well produced, detailed and unambiguous. This could be a natural qualitative extension of the work carried out for P5.

For M3, learners must produce clear and accurate answers to calculations to establish the duties, ratings and flow rates for a variety of different refrigeration components and select these using manufacturers information. Learners should be able to apply the results of their calculations to a selection of currently available plant and equipment and clearly specify suitable projects where they could be used. They should use evaluative skills to explain why these would be suitable for use in particular projects. Learners will build and expand on knowledge gained for P5.

For M4, learners must analyse installation drawings, design calculations and manufacturers' data to produce clear proposals for the testing, commissioning, planned maintenance and hand-over documentation for refrigeration plant on both integrated and a stand-alone air conditioning systems. They are expected to produce comprehensive details of how the system that has been designed in M2 will be tested and commissioned using the design criteria and specification. The documents produced for M4 should be to industry standards and should refer to the required codes of practice and regulations for testing and commissioning. Learners should also show evaluative skills to provide all relevant data from manufacturer's literature for the planned maintenance of the plant and equipment. The manufacturers' literature should form part of the evidence, but will not be considered sufficient on its own.

For M5, learners must discuss the impact of current and planned national and international protocols and legislation relating to the design, installation, commissioning and use of air conditioning and refrigeration systems. They should analyse legislative reports and material on refrigerants and write a report that clearly discusses the impact of new national and international proposals for designers, installers and end users. The report should allow learners to show their evaluative skills in presenting their own conclusive opinions. Learners will build on and expand the evidence for P7.

To achieve a distinction grade learners must meet all of the pass and merit grade criteria **and** the two distinction grade criteria.

For D1, learners must investigate possibilities for new, more recent methods of refrigeration technology used in air conditioning and compare and contrast these to older methods with regard to performance, cost, energy efficiency and overall benefits to the environment. They will need to use analytical skills to develop a report that clarifies the viabilities of the items researched in terms of real advantages or disadvantages to human life, the environment, financial costs and health and safety. Learners should also use personal judgement to compare and contrast the chosen technology and arrive at conclusions that can be substantiated by the evidence.

For D2, learners must appraise all the options available for designers and installers of refrigeration systems and analyse what ultimately determines design solutions to be chosen and consequently the impact on our world today. This should be backed up by clear forward thinking concerning the impact that attitudes towards design selection processes have on environmental issues such as global warming.

Links to National Occupational Standards, other BTEC units, other BTEC qualifications and other relevant units and qualifications

The learning outcomes in this unit are closely linked with, for example, *Unit 2: Construction and the Environment, Unit 4: Science and Materials in Construction and the Built Environment, Unit 8: Graphical Detailing in Construction and the Built Environment, Unit 32: Building Services Control Systems, Unit 33: Building Services Science* and *Unit 36: Fluids Static and Dynamic in Building Services Engineering*, together with similar units at Higher National and degree level.

This unit may have links to the Edexcel Level 3 Technical and Professional NVQs for Construction and the Built Environment. Updated information on this, and a summary mapping of the unit to the CIC Occupational Standards, is available from Edexcel. See *Annexe D: National Occupational Standards/mapping with NVQs*.

The contents of this unit also covers some of the knowledge and understanding associated with SummitSkills National Occupational Standards, particularly, Unit 008: Design RAC systems — small commercial refrigeration and air conditioning systems.

The content of this unit covers some of the knowledge and understanding associated with Summit Skills N-SVQ Level 3: Building Services Engineering Technology and Project Management, particularly, Unit SST/NOS 3: Apply Design Principles to Building Services Engineering Projects, Unit SST/NOS 5: Monitor Commissioning and Testing Procedures for Building Services Engineering Projects and Unit SST/NOS 7: Provide Technical and Functional Information to Relevant People.

The content of this unit will also provide a developmental stage in acquiring some of the knowledge and understanding associated with Summit Skills N-SVQ Level 4: Building Services Engineering Technology and Project Management, particularly, SSTE/NOS 7: Prepare and Advise on Building Services Engineering Project Design Recommendations and SSTE/NOS 8: Prepare and Agree Detailed Building Services Engineering Project Designs.

This unit presents opportunities to demonstrate key skills in application of number, communication and problem solving. Opportunities for satisfying requirements for Wider Curriculum Mapping are summarised in *Annex F: Wider curriculum mapping*.

Essential resources

Centres should have access to a wide range of hard copy or on line technical and manufacturers' literature, some of which are listed below.

The availability of visual aids such as the range of refrigeration plant and components indicated in the learning outcome 2 is considered highly advantageous. These can be in the form of models but preferably should be part of live installations.

Centres should have access to sets of architectural drawings, refrigeration system installations and schematic drawings to support the learning process and to facilitate assessment. Where these drawings are used as part of the assessment process it is recommended that repeated use of the same building is avoided to maintain the freshness and validity of the assessment process.

Learners should be made familiar with industry-recognised software. This should include size, select and specify pipework, plant, equipment. It is vital, however, that if such software is used, learners are assessed as being able to complete the calculations required using recognised manual procedures. The same principle applies to the graphical detailing required for learning outcome 3.

Indicative reading for learners

Textbooks

Chadderton D — *Air Conditioning: A Practical Introduction, 2nd Edition* (Spon Press, 1999) ISBN 0419226109

Chadderton D — *Building Services Engineering, 5th Edition* (Taylor & Francis, 2007) ISBN 0415413559

Chartered Institute of Building Services Engineer — *Energy Efficiency in Buildings* (CIBSE, 2004) ISBN 1903287340

Chartered Institute of Building Services Engineer — *Environmental Design, 7th Edition* (CIBSE, 2006) ISBN 1903287669

Chartered Institute of Building Services Engineer — *Ventilation and Air Conditioning* (CIBSE, 2001) ISBN 1903287162

Cook N — *Refrigeration and Air-conditioning Technology* (Macmillan Education, 1995) ISBN 0333609581

Kaminski D and Jensen M — *Introduction to Thermal and Fluid Engineering* (John Wiley & Sons, 2004) ISBN 0471268739

Martin P, Oughton D and Hodkinson S — *Faber and Kell's Heating and Air-conditioning of Buildings, 9th Edition* (Architectural Press, 2001) ISBN 075064642X

Trott A and Welch T — *Refrigeration and Air Conditioning, 3rd Edition* (Butterworth-Heinemann, 1999) ISBN 075064219X

Website

www.ior.org.uk Institute of Refrigeration

Key skills

Achievement of key skills is not a requirement of this qualification but it is encouraged. Suggestions of opportunities for the generation of Level 3 key skill evidence are given here. Tutors should check that learners have produced all the evidence required by part B of the key skills specifications when assessing this evidence. Learners may need to develop additional evidence elsewhere to fully meet the requirements of the key skills specifications.

Application of number Level 3	
When learners are:	**They should be able to develop the following key skills evidence:**
• determining sensible and latent heat gains for at least two different building locations requiring air conditioning • producing basic, functional and workable designs • producing clear and accurate answers to calculations to establish the duties, ratings and flow rates for a variety of different refrigeration components and selecting these using manufacturers information • analysing installation drawings, design calculations and manufacturers' data to produce clear proposals for the testing, commissioning, planned maintenance and hand-over documentation for refrigeration plant on both integrated and stand-alone air conditioning systems.	N3.1 Plan an activity and get relevant information from relevant sources. N3.2 Use your information to carry out multi-stage calculations to do with: a amounts or sizes b scales or proportion c handling statistics d using formulae. N3.3 Interpret the results of your calculations, present your findings and justify your methods.

Communication Level 3	
When learners are:	**They should be able to develop the following key skills evidence:**
• establishing the features and characteristics of the principle components of refrigeration systems and their configuration for the purpose of providing simple air conditioning solutions • specifying the material, equipment, instruments and installation requirements necessary to install, test and commission typical refrigeration systems • analysing how the refrigeration cycle works, explaining and illustrating the thermodynamic changes within the working during the operation of the cycle and its variants • discussing the impact of current and planned, national and international protocols and legislation relating to the design, installation, commissioning and use of air conditioning and refrigeration systems • investigating possibilities for new, more recent methods of refrigeration technology used in air conditioning and comparing and contrasting these to older methods with regard to performance, cost, energy efficiency and overall benefits to the environment • appraising all the options available for designers and installers of refrigeration systems and analyse what ultimately determines design solutions to be chosen and consequently the impact on our world today.	C3.1a Take part in a group discussion. C3.1b Give a talk of at least eight minutes using an image or other support material. C3.2 Read and synthesise information from at least **two** documents about the same subject. Each document must be a minimum of 1000 words long. C3.3 Write **two** different types of documents each one giving different information about complex subjects. One document must be at least 1000 words long.

Problem solving Level 3	
When learners are:	**They should be able to develop the following key skills evidence:**
• determining sensible and latent heat gains for at least two different building locations requiring air conditioning • producing a basic, functional and workable design proposal for refrigeration based air conditioning systems for simple buildings, selecting and producing a schedule of the required refrigeration plant and equipment • analysing installation drawings, design calculations and manufacturers' data to produce clear proposals for the testing, commissioning, planned maintenance and hand-over documentation for refrigeration plant on both integrated and a stand-alone air conditioning systems.	PS3.1 Identify a problem and identify different ways of tackling it. PS3.2 Plan and implement at least one way of solving the problem. PS3.3 Check if the problem has been solved and review your approach to problem solving.